

The documentation and process conversion measures necessary to comply with this revision shall be completed by 23 MAR 94.

INCH-POUND

MIL-S-19500/231F
23 September 1993
SUPERSEDING
MIL-S-19500/231E
10 March 1992

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, SWITCHING
TYPES 1N3600, 1N4150-1, AND 1N4150UR-1
JAN, JANTX, AND JANTXV

JANS1N4150-1 is superseded by MIL-S-19500/609
JANS1N6640 (see 6.3 and 6.3.1).

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for silicon, switching diodes. Three levels of product assurance are provided for each device type as specified in MIL-S-19500 (see 6.2).

1.2 Physical dimensions. See figures 2, 3, and 4.

1.3 Maximum ratings.

Type	$V_{(BR)}$ $I_R = 10 \mu A$	V_{RWM}	I_O 1/ $T_A = +25^\circ C$	I_{FSM} $t_p = 1 \mu s$	T_{STG}, T_J T_L or T_{EC}	$Z_{\theta JX(max)}$	$R_{\theta JL(max)}$	$R_{\theta JEC(max)}$ 2/
	<u>V dc</u>	<u>V (pk)</u>	<u>mA</u>	<u>A (pk)</u>	<u>°C</u>	<u>°C/W</u>	<u>°C/W</u>	<u>°C/W</u>
1N3600	75	50	200	4.0	-65 to +175	50	250	100
1N4150-1	75	50	200	4.0	-65 to +175	50	250	100

1/ Derate at 2.0 mA dc/°C above $T_L = +75^\circ C$ for axial lead L = 3/8 inches or derate 3.1 mA dc/°C above $T_{EC} = 110^\circ C$ for UR suffix devices.

2/ For UR devices only.

1.4 Primary electrical characteristics at $T_A = +25^\circ C$, unless otherwise indicated.

	V_{F1}	V_{F2}	V_{F3}	V_{F4}	V_{F5}	I_{R1} at
Limits	$I_F = 1$ mA dc	$I_F = 10$ mA dc	$I_F = 50$ mA dc (pulsed)	$I_F = 100$ mA dc (pulsed)	$I_F = 200$ mA dc (pulsed)	$V_R = 50$ V dc
	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>μA dc</u>
minimum	0.540	0.660	0.760	0.820	0.870	-----
maximum	0.620	0.740	0.860	0.920	1.000	0.1

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ECT, 1507 Wilmington Pike, Dayton, OH 45444-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

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1.4 Primary electrical characteristics at $T_A = +25^\circ\text{C}$, unless otherwise indicated - Continued.

	I_{R2}	C	t_{rr1}
Limits	$V_R = 50 \text{ V dc}$ $T_A = +150^\circ\text{C}$	$V_R = 0; f = 1 \text{ MHz};$ ac signals = 50 mV(p-p)	$I_F = I_R = 10 \text{ to } 100 \text{ mA dc};$ $R_L = 100 \text{ ohms}$
	<u>$\mu\text{A dc}$</u>	<u>pf</u>	<u>ns</u>
minimum	-----	-----	-----
maximum	100	2.5	4

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARDS

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

V_{fr}	Forward recovery voltage. Specified maximum forward voltage used to determine forward recovery time.
I_{BR}	Current for testing reverse breakdown voltage.
EC	Endcap

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 and figures 2 and 3 herein.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-STD-750 and MIL-S-19500, and herein. Lead finish may be specified in the contract (see 6.2), without affecting the qualified product status of the device or applicable JAN marking.

3.3.2 Diode construction. All "-1" devices shall be metallurgically bonded double plug construction in accordance with the requirements of category I, II, or III (see MIL-S-19500). The UR version devices shall be structurally identical to the leaded devices, except for lead terminations.

3.4 Marking. Devices shall be marked as specified in MIL-S-19500.

3.4.1 Marking for U devices. For U version devices only, all marking may be omitted from the body (except for 3.5), but shall be retained on the initial container.

3.5 Polarity. alternately, the polarity of all types shall be indicated with a contrasting color band to denote the cathode end. For UR suffix devices a minimum of three contrasting color dots spaced around the cathode end of the device may be used.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500 and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2.1 Construction verification. Cross sectional photos from 3 devices shall be submitted in the qualification report.

4.2.2 Group E inspection. Group E inspection shall be in accordance with MIL-S-19500 and table II herein. Thermal resistance read and record data shall be included in the qualification report.

4.3 Screening (JAN, JANTX, AND JANTXV levels only). Screening shall be in accordance with MIL-S-19500 (table II), and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurement	
	JAN level	JANTX and JANTXV levels
3a	Temperature cycling per MIL-S-19500 "TX level".	Temperature cycling per MIL-S-19500.
3c <u>1/</u>	Thermal impedance (see 4.5.5)	Thermal impedance (see 4.5.5)
9	Not applicable	Not applicable
10	Not applicable	Method 1038, condition A, t = 48 hours
11	Not applicable	I_{R1} and V_{F5}
12	Not applicable	Method 1038, condition B, t = 48 hours (see 4.3.1)
13 <u>2/</u> <u>3/</u>	Not applicable	Subgroup 2 of table I herein; $\Delta I_{R1} \leq 100$ percent of initial value or ± 40 nA dc, whichever is greater. $\Delta V_{F5} \leq \pm 0.025$ V (pk).

1/ Thermal impedance shall be performed any time after screen 3a, temperature cycling.

2/ $Z_{\theta JX}$ need not be performed at screen 13 if performed prior to screen 13.

3/ $POA \leq 5\%$.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows (see 4.5.3):

- MIL-STD-750, method 1038, test condition B, T_A = room ambient as defined in the general requirements of MIL-STD-750, (see 4.5), $f = 50-60$ Hz, $I_O = 200$ mA dc, $V_{RWM} = 50$ V(pk).
- MIL-STD-750, method 1038, test condition B, $T_A = 120^\circ\text{C}$, $I_f = 33.75$ mA dc.
- MIL-STD-750, method 1038, test condition B, $I_F = 180$ mA dc, T_A = room ambient as defined in the general requirements of paragraph 4.5 of MIL-STD-750.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein. Thermal impedance $Z_{\theta JX}$ conditions are as follows:

$$I_H = 300 \text{ mA to } 500 \text{ mA}$$

$$t_H = 10 \text{ ms}$$

$$I_M = 1 \text{ mA to } 10 \text{ mA}$$

$$t_{MD} = 100 \mu\text{s maximum}$$

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the applicable steps and footnotes of table III herein.

4.4.2.1 Group B inspection, table IVb (JAN, JANTX and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
2	4066	Test condition A, $I_{FSM} = 0.5 \text{ A (pk)}$; $I_D = 0$; 10 surges at 1 per minute (max) surge; duration = 1 s.
3	1027	T_A = room ambient as defined in the general requirements of MIL-STD-750, (see 4.5), $f = 50\text{--}60 \text{ Hz}$ (see 4.5.1); $I_O = 200 \text{ mA}$. $V_R = V_{RM} = 50 \text{ V (pk)}$.
4	2075	See 4.5.4 herein.
5	3101 or 4081	See 4.5.6 herein.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the applicable steps of table III herein.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Condition
2	2036	Tension: Test condition A; weight 4 pounds; $t = 15 \pm 3 \text{ seconds}$. Lead fatigue: Test condition E; weight = 16 ounces.
6	1026	T_A = room ambient as defined in the general requirements of MIL-STD-750, (see 4.5), $f = 50\text{--}60 \text{ Hz}$ (see 4.5.1); $I_O = 200 \text{ mA}$. $V_R = V_{RM} = 50 \text{ V (pk)}$.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables as follows.

4.5.1 Life tests. AC tests shall be conducted with a half-sine wave of the peak voltage specified herein impressed across the diode in the reverse direction, followed by a half-sine waveform of the average rectified current specified herein. The forward conduction angle of the rectified current shall be not greater than 180° nor less than 150° .

4.5.2 Forward recovery voltage and time. Forward recovery time shall be measured as the time interval between zero time and the point where the pulsed has decreased to 110 percent of the steady-state value of V_F when I_F = as specified in Group A, subgroup 7. The maximum rise time of the response detector shall be 1 ns.

4.5.3 Pulse measurements. Conditions of pulsed measurements shall be specified in section 4 of MIL-STD-750.

4.5.4 Decap internal visual scribe and break for -1 devices (DPA). Scratch glass at cavity area with diamond scribe. Carefully snap open. Using 30X magnification examine the area where die (or bond material) are in contact with the plugs, verify metallurgical bonding area. If the verification of the metallurgical bonding area is in question, an engineering evaluation shall be performed and the devices disposition accordingly.

4.5.5 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3101. The maximum limit (not to exceed the Group A, Subgroup 2 limit) for $Z_{\theta JX}$ in screening (table II of MIL-S-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable X, R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for Engineering evaluation and disposition.

4.5.5.1 Thermal impedance ($Z_{\theta JX}$ measurements) for initial qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3101 (read and record date $Z_{\theta JX}$). $Z_{\theta JX}$ shall be supplied on one lot (500 devices minimum and a thermal response curve shall be submitted). Twenty two of these samples shall be serialized and provided to the qualifying activity for correlation prior to shipment of parts. Measurements conditions shall be in accordance with 4.4.1.

4.5.6 Thermal resistance. Thermal resistance measurement shall be performed in accordance with MIL-STD-750, method 3101 or 4081. Forced moving air or draft shall not be permitted across the devices during test. The maximum limit for $R_{\theta JL}$ under these test condition shall be $R_{\theta JL(max)} = 250^{\circ}\text{C/W}$ and $R_{\theta EC(max)} = 100^{\circ}\text{C/W}$. The following conditions shall apply:

$I_H = 75 \text{ mA to } 300 \text{ mA}$

$t_H = 25 \text{ seconds minimum}$

$I_M = 1 \text{ mA to } 10 \text{ mA}$

$t_{HD} = 70 \mu\text{s maximum}$

LS = Lead spacing = 3/8 inch as defined on figure 1

LS = 0 for UR versions.

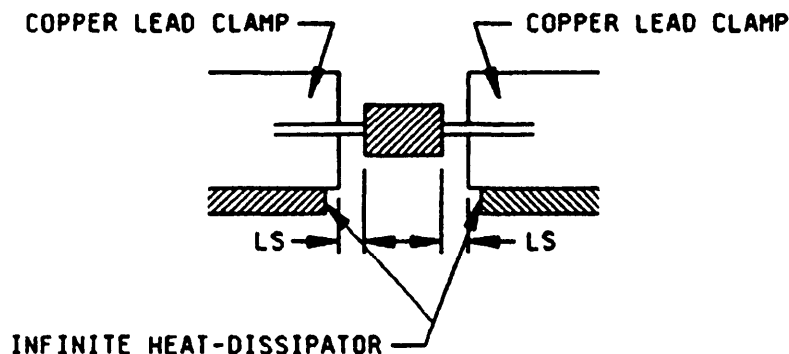


FIGURE 1. Mounting arrangement.

TABLE 1. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance	3101	See 4.4.1	$Z_{\theta JX}$		50	$^{\circ}\text{C/W}$
Forward voltage	4011	$I_F = 1 \text{ mA dc}$	V_{F1}	0.540	0.620	V dc
Forward voltage	4011	$I_F = 10 \text{ mA dc}$	V_{F2}	0.660	0.740	V dc
Forward voltage	4011	$I_F = 50 \text{ mA dc (pulsed) see 4.5.1}$	V_{F3}	0.760	0.860	V dc
Forward voltage	4011	$I_F = 100 \text{ mA dc (pulsed) see 4.5.1}$	V_{F4}	0.820	0.920	V dc
Forward voltage	4011	$I_F = 200 \text{ mA dc (pulsed) see 4.5.1}$	V_{F5}	0.870	1.000	V dc
Breakdown voltage	4021	$I_{(BR)} = 10 \mu\text{A dc}$	V_{BR1}	75		V dc
Reverse current	4016	DC method; $V_R = 50 \text{ V dc}$	I_{R1}		0.10	$\mu\text{A dc}$
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^{\circ}\text{C}$				
Reverse current	4016	DC method; $V_R = 50 \text{ V dc}$	I_{R2}		100	$\mu\text{A dc}$
<u>Subgroup 4</u>						
Junction capacitance	4001	$V_R = 0 \text{ V dc}; f = 1 \text{ MHz};$ $V_{\text{sig}} = 50 \text{ mVp-p maximum}$	C		2.5	pF
Reverse recovery time	4031	Test condition A; $I_F = I_{RM} = 10 \text{ to } 100 \text{ mA dc};$ $R_L = 100 \text{ ohms}; C \geq 1 \text{ nF}; R \geq 1000 \Omega;$ $i_{R(\text{REC})} = 10\% I_{RM}$	t_{rr1}		4	ns
<u>Subgroups 5 and 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Forward recovery voltage and time	4026	$I_F = 200 \text{ mA dc};$ $t_r = 0.4 \text{ ns; (see 4.5.2)}$	V_{fr} t_{fr}		5 10	V (pk) ns

1/ For sampling plan, see MIL-S-19500.

TABLE II. Group E inspection (all quality levels) for qualification only.

Inspection 1/	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature shock (glass strain)	1056	500 cycles	
Electrical measurement		See table III, steps 1, 2, and 3.	
<u>Subgroup 2</u>			
Intermittent operating life	1037	6,000 cycles; $V_{RWM} = 50 \text{ V}$; $I_O = 200 \text{ mA}$	45 devices c = 0
Electrical measurement		See table III, steps 1, 2, and 3.	
<u>Subgroup 3</u>			
Not applicable			
<u>Subgroup 4</u>			22 devices c = 0
Thermal resistance	3101 or 4081	See 4.5.6	
<u>Subgroup 5</u>			45 devices c = 0
Monitored mission temperature cycling	1055		
Electrical measurements		See table III, steps 1, 2, and 3	

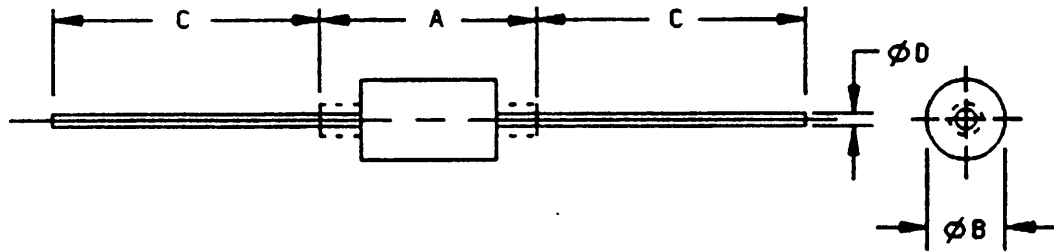
1/ For sampling plan, see MIL-S-19500.

TABLE III. Groups A, B, C, and E electrical measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1	Forward voltage	4011	$I_F = 200 \text{ mA dc}$ (pulsed)	V_{FS}	0.870	1.000	V dc
2	Reverse current	4016	DC method; $V_R = 50 \text{ V dc}$	I_{R1}		0.10	$\mu\text{A dc}$
3	Thermal impedance	3101	see 4.5.5	$Z_{\theta JX}$		50	$^{\circ}\text{C/W}$

1/ The electrical measurements for table IVb of MIL-S-19500 are as follows: Subgroups 2, 3, and 6, see table III herein, steps 1, 2, and 3.

2/ The electrical measurements for table V of MIL-S-19500 are as follows: Subgroups 2 and 6, see table III herein, steps 1, 2, and 3.

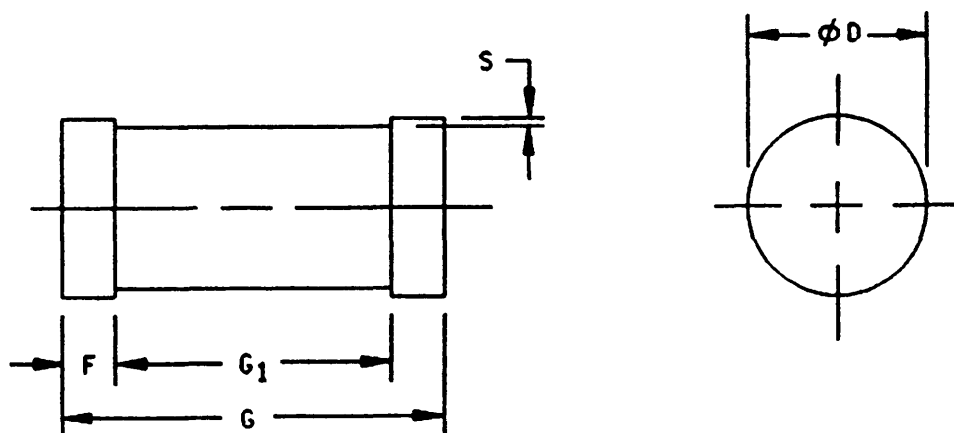


Types	Symbol	Dimensions				Notes
		Inches		Millimeters		
		Min	Max	Min	Max	
1N3600	A	.140	.300	3.56	7.62	
	øB	.056	.107	1.42	2.72	3,4
	C	1.000	1.500	25.40	38.10	2
	øD	.018	.022	0.46	0.56	6
1N4150-1	A	.140	.180	3.56	4.57	5
	øB	.056	.075	1.42	1.91	3,4
	C	1.000	1.500	25.40	38.10	2
	øD	.018	.022	0.46	0.56	6

NOTES:

1. Metric equivalents are given for general information only.
2. Both leads shall be within the specified limits (see 3.3.1).
3. The maximum diameter of dimension B shall apply over full length of dimension A.
4. The minimum diameter of dimension B shall apply over at least .075 inch (1.91 mm) of dimension A.
5. Ferrule is optional on type 1N3600 and 1N4150-1 for dimension A.
6. The specified lead diameter applies in the zone between .050 inch (1.27 mm) and 1.00 inches (25.4 mm) from the diode body to the end of the lead. Outside of this zone the lead diameter shall not exceed diameter B.

FIGURE 2. Physical dimensions (types 1N3600 and 1N4150-1).



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
φD	.063	.067	1.60	1.70
F	.016	.022	0.41	0.55
G	.130	.146	3.30	3.70
G ₁	.100 ref		2.54 ref	
S	.001 min		0.03 min	

NOTES:

1. Dimensions are in inches.
2. Metric equivalent are given for general information only.

FIGURE 3. Physical dimensions and configuration for 1N4150UR-1 (DO-213AA).

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Issue of DODISS to be cited in the solicitation.
- b. Lead finish as specified (see 3.3.1).
- d. Type designation and product assurance level.

6.3 Substitution information. The 1N6640 (MIL-S-19500/609) supersedes the 1N4150-1. The JANS1N6640 supersedes the JANS1N4150-1. Existing stock of JANS1N4150-1 may be used until exhausted.

6.3.1 Cross reference supersession list. JANS level will no longer be built to this specification. Devices in stock are acceptable provided the date code does not exceed the date of implementation of this specification. Devices required for space flight applications are found on MIL-S-19500/609. A PIN for PIN replacement table follows, and these devices are directly interchangeable:

JANS Nonpreferred PIN	JANS Preferred PIN
1N4150-1	1N6640

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:

Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:

Army - AR, AV, MI
Air Force - 85, 99
DLA - ES

User activities:

Army - SM
Navy - AS, CG, MC, OS, SH
Air Force - 19

Preparing activity:

Navy - EC

Agent:

DLA - ES

(Project 5961-1379)